Insights

A publication of the Ontario Forest Research Institute

What do we need to know to estimate future wood supply?

Researchers help identify the gaps

By Lisa J. Buse

MNR's *Provincial Wood Supply Strategy*, released in 2004, identifies critical wood supply issues for Ontario and provides approaches for addressing them. One of the strategy's underlying messages was that the province's wood supply predictions could be better.

After the strategy's release, the Minister's Council on Forest Sector Competitiveness stated that improving wood supply estimates was critical to maintain both public and forest industry confidence in Ontario's forest sector. To address this need, a team of MNR researchers and policymakers were asked to identify the most pressing research needs to fill the information gaps in modelling wood supply and to develop an action plan to fill those gaps.

So, what's the problem with existing predictions? According to Michael Ter-Mikaelian, OFRI research scientist and project co-lead: "These predictions are made using models that have to factor in many different, sometimes interacting pieces of information. For wood supply, these inputs may include forest inventory data – how many of what types of trees are out there; growth and yield data – how fast they grow, which depends on factors such as site, climate, and density; and disturbance effects – both natural and human-caused."

Since model predictions rely on the quality of input data and a simplified set of assumptions about the processes being

Continued on Page 2

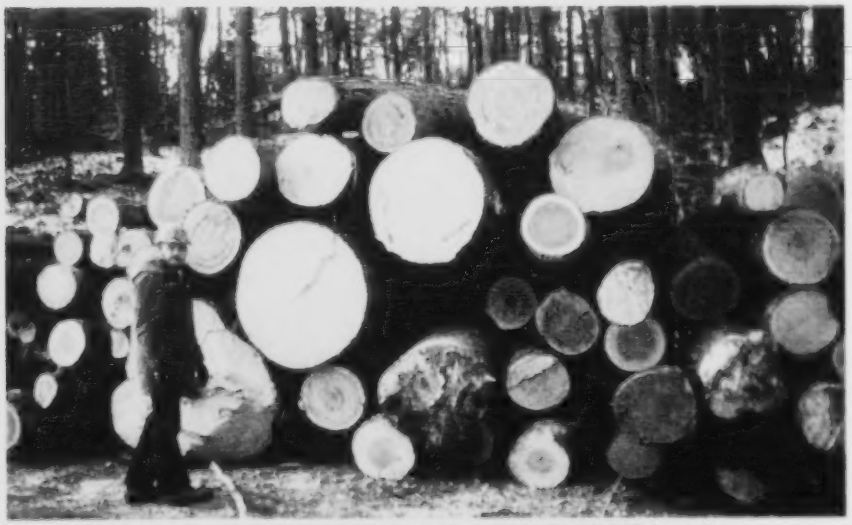


Photo: MNR archives

Improving predictions of future wood supply will help ensure the sustainability of Ontario's forest sector.

Volume 7, Number 2
SPRING 2006

In this issue ...

Towards better wood supply estimates 1
Models assist softwood lumber negotiations 2
Vegetation management to promote aspen and spruce 4
Storing more carbon in Ontario's forests 5
Protecting investments in long-term hardwood research 6
Facts about OFRI 7
Staff profile: Bill Cole 8
Using large-scale photography in GLSL forest inventory 9
Thin Green Line proceedings 10
OFRI forest research trivia 10
Partial harvesting in old growth white pine 11
Blister rust-resistant white pine 13
MNR's world-class genetic archives 15
Red pine decline in southern Ontario 16
Identifying tree fungi using DNA 17
Tools for estimating tree decay 18
FTC defoliation and aspen stand dynamics 18
OFRI staff news 19
Ask the expert: biomass for biofuel 20

Ontario Ministry of Natural Resources
Applied Research and Development Branch

Aussi disponible en français.

Ontario

Continued from Page 1

predicted – with many factors affecting those processes – errors in any of these add to or even multiply uncertainties in the model's outputs, in this case, wood supply predictions."

He continues, "Ideally, when a model is used to make predictions, a range of values with associated probabilities of occurrence [confidence intervals] are produced. Since wood supply predictions rely on many, varying input data layers, each with a different level of uncertainty, it is difficult to get a quantitative estimate of these uncertainties for all input data and modelling assumptions. The sheer number of uncertainties makes identifying the priorities essential for progress towards reliable estimates."

The December 2005 *Art and Science of Wood Supply Estimation Workshop* in Sault Ste. Marie, the organization of which was led by Ter-Mikaelian, was one step towards identifying these priorities. Workshop participants first listened to a suite of presentations to help orient them to wood supply prediction efforts and challenges in other areas of Canada and the eastern United States and to stimulate discussions about how these practices could apply to Ontario.

Steve Colombo, OFRI research scientist and project co-lead, reports, "Rather than the usual facilitated discussion approach, workshop organizers chose a unique, open-spaces approach to brainstorm knowledge gaps and prioritize them in a two-step process. This approach proved efficient in gathering a lot of information in a short period and allowed participants ample time for discussions and networking. However, it left little opportunity to clarify people's contributions or reconcile duplication or overlap. While this made synthesizing the results somewhat challenging, overall the method was well-suited to the intent of the workshop – intensive group brainstorming."

Can Ontario's wood supply predictions be improved? "Most certainly," Ter-Mikaelian emphasizes. "Now that we know where to focus our research efforts, we can start filling the knowledge gaps and reducing the associated uncertainties in predictions, but as with many other issues in forest management, improvements will take time."

Dave Hayhurst, acting manager of MNR's Wood Allocation and Measurement Section, points out, "Efforts associated with this project have already narrowed down our priorities for reducing uncertainties. Topping the list are developing a stronger linkage between our forest resource inventory and growth and yield data, improving our knowledge of forest succession at various stages of stand development, and developing better yield curves for natural and planted stands. These and other priorities identified at the workshop will be among MNR's highest priorities for research and development work over the next few years."

Ter-Mikaelian, Colombo, and the rest of their team will combine a synthesis of workshop findings with the results of an Ontario-wide survey conducted prior to the workshop to develop recommendations for addressing the highest-priority knowledge gaps. This synthesis will be released in summer 2006 as an OFRI Forest Research Information Paper. As well, the team is conducting an inventory of past and current MNR research projects related to wood supply to identify existing but untapped knowledge to add to their findings.

For more information about this project, contact Michael Ter-Mikaelian at (705)946-7432, michael.termikaelian@mnr.gov.on.ca, or visit and http://ofri.mnr.gov.on.ca/ofriresearch.cfm and select *Forest Growth and Yield/Modelling*. In addition to Ter-Mikaelian and Colombo, workshop organizing committee members were OFRI's Jean-Marie Sobze, Peter Henry from MNR's Forest Management Planning Section, and Gord King from MNR's Wood Allocation and Measurement Section.

Modeller helps Ontario and the United States compare "apples with apples" during softwood lumber talks

By Abigail M. Obenchain

Canada's softwood lumber dispute with the United States has dragged on for more than 20 years. Why has it taken so long to resolve, and how can forest researchers help?

As with any international trade issue, politics has been a formidable obstacle but is outside researchers' domain. However, according to Leigh Colpitts, an international trade specialist with MNR's Forests Division who has devoted much time to the softwood lumber issue, one researcher made a significant contribution to moving the softwood lumber dispute closer to resolution by producing mathematical equations known as *stem profile models*.

"OFRI's Voyteck Zakrzewski has developed models that have been enormously helpful to Ontario," Colpitts says. "Voyteck's work has carried considerable weight in the investigation process by allowing for more meaningful and accurate comparisons of Ontario's timber prices to the prices in other jurisdictions."

Zakrzewski explains, "It has been very challenging to determine whether Canadian lumber is priced fairly compared with American lumber because various jurisdictions in these two countries have been using differing rules for estimating timber volumes. Using traditional and regionally varying measures in logging leaves the United States as one of the last holdouts in a metric world.

"The main concern is not that the U.S.'s traditional timber scaling methods are not metric but that their resulting timber volume estimates are biased and imprecise. This practice not only often puts them at a disadvantage but also creates uncertainties in the global timber trade."

Stem profile models (also called *taper models*) can answer many questions related to timber scaling. These models have helped resolve issues related to estimating timber product volumes for the softwood lumber dispute because they provide a consistent and reasonably accurate approach to estimating a tree's diameter at any place along the stem. "These models allow us to more accurately estimate the wood volume of trees in a forest stand and the types of products

2007-05537/

those trees can be used for," Zakrzewski says.

Stem profile models must be locally valid to produce legally defensible estimates. To assure the local validity of the models, researchers investigate factors influencing tree stem shape and branch patterns. These taper models usually account for genetic factors, such as the tree species, as well as ecological growing conditions determined by geology and climate or forest stand density, which can all affect tree growth and shape.

"The more meaningful variables we can account for in the model, the more valid the results will be. Also, the statistical procedures involved in model application can be crucial for assuring its local validity," Zakrzewski asserts.

Zakrzewski first began working on stem profile models for Ontario tree species back in 1991, and his work contributed to development of BUCK, stem profile calibration software, and the TCM-PAM system, timber cruising software used to estimate timber volume at the stand or individual tree level. In 2001, Colpitts, Steve Banducci, Greg Hannah, and other staff with MNR's Forest Business and Economics Section who were familiar with Zakrzewski's work realized that he might be able to help them process Ontario harvest records so that the volume estimates conformed to U.S. standards, "allowing comparison of apples with apples."

Eventually, Bill Kissick, then manager of Forest Business and Economics Section and now director of MNR's Forest Sector Competitiveness Secretariat, proposed what Zakrzewski describes as "the long-sighted concept of producing mensurational tools developed jointly by the United States and Canada to remove any future potential issues of discontent about estimating tree volume."

This proposal led to a strong and productive partnership among Zakrzewski and his colleagues in Forest Business and Economics Section and at Michigan State University, as well as resource professionals with the Canadian Forest Service, the USDA Forest Service, and the departments of natural resources in Michigan, Wisconsin, and Minnesota. Thus, the Great Lakes Stem Profile Modelling Project was born, sparking cross-border cooperation on a consistent, scientifically defensible approach to estimating wood product volume using stem profile models.

Photo: Trudy Valfrinet

Modeller Voteck Zakrzewski demonstrates one of his stem profile models, which contributed to the recent softwood lumber negotiations with the United States by allowing more meaningful and accurate comparisons of timber prices.

Zakrzewski reports, "We are focusing mostly on boreal and Great Lakes-St. Lawrence species: jack pine, red pine, white pine, black spruce, white spruce, white cedar, balsam fir, white birch, sugar maple, red maple, black cherry, aspen, and balsam poplar. We define static taper models, which estimate a tree's current volume, while also developing dynamic models, which simulate how much wood volume the tree will add over time."

In support of defining stem profile models, Zakrzewski and his colleagues have developed the Stem Data Management System (SDMS), a computer program that facilitates the collation, management, and analysis of tree stem data.

"Its aim is to allow the integration of data from a variety of sources and formats into a single, unified database that can be easily used in stem profile modelling," Zakrzewski explains. "It is important to remember that data is not information, and the latter is what people are after. You can have millions of bytes of data, but if the measurements collected are not suited for your model, or if they are not processed to produce a functional modelling tool – mathematical, tabular, physical, etc. – they are worthless."

Zakrzewski says that his involvement in the softwood lumber dispute, which included testifying in front of the American legal team, has been one of the highlights of his career. "It was obviously rewarding to see my product supporting top corporate priorities. At times it was even fun. The lawyers on both sides asked intelligent and sometimes surprising questions about tree growth and tree stem profile models, which I found very entertaining. For example, they were interested to learn that DBH does not move upwards as a tree grows."

What does the future hold for Zakrzewski and the Great Lakes Stem Profile Modelling Project? "My role in the softwood lumber dispute has almost concluded for now; there are still occasional requests from Washington, for example, to compare trees from Ontario and New Brunswick," he says. "But I will be working with specialists in MNR's Industry Relations Branch on wood scaling issues. I will continue to cooperate with my U.S. research partners and foresters in the area of modelling, particularly on developing a dynamic taper model and using modelling tools to inventory biomass, which is a significant challenge and becoming more important given the current emphasis on bioenergy and biofuels.

"We also have some work remaining to complete the SDMS, including expanding the database – saving past MNR investment in data collection if you will. I would also like to produce a user-friendly GIS-linked interface for this product to make it accessible to others."

For more information about the Great Lakes Stem Profile Modelling Project or SDMS, contact Voyteck Zakrzewski, (705)946-7437, voyteck.zakrzewski@mnr.gov.on.ca. To view a PowerPoint presentation about the use of stem profile models in the softwood lumber dispute, visit OFRI's website at http://ofri.mnr.gov.on.ca and page down to *Did You Miss the Seminar Entitled How the Softwood Lumber Countervailing Duty Case Enhanced Stem Profile Modelling in the Great Lakes Region?* In addition, *Forest Science* will soon publish an article entitled *Regional Stem Profile Model for Cross Border Comparisons of Harvested Red Pine* (Pinus resinosa *Ait.) in Ontario and Michigan*, authored by Zakrzewski and Michigan State University's David MacFarlane. You can visit the BUCK website at http://www.forestyield.com.

New study aims to spruce up mixedwoods

By Lisa J. Buse

Although researchers know a lot about spruce growth response in conifer plantations, they know little about how this species grows in mixedwoods. As the amount of forests managed as mixedwoods increases, understanding crop tree responses in these stands will be critical for estimating long-term growth and yield and thus potential wood supply.

That's why in 2002, OFRI research scientist Bill Parker teamed up with Doug Pitt of the Canadian Forest Service-Great Lakes Forestry Centre to study spruce-aspen mixedwoods in northeastern Ontario. "We realized that to manage mixedwoods, we needed to know much more about regeneration mechanisms in these stands," Parker says.

According to Pitt, "The intent of the study is to develop vegetation management strategies for regenerating spruce-aspen mixedwoods to yield an aspen fibre crop by age 35, followed by high-quality spruce sawlogs at 80 years. Essentially, we're hoping to optimize the yield of both species over time.

"For now, we're comparing the effects of early vegetation control, for none, two, and four years, consecutively, and varying aspen stem densities – 400, 800, 1,200, and 2,000 stems per hectare and natural – on spruce and aspen growth.

"Our hope," Pitt emphasizes, "is that spruce stem quality will be improved by adjacent aspen, which in turn will provide forest industry with an interim crop while waiting for the spruce sawlogs."

Photo: Canadian Forest Service-Great Lakes Forestry Centre

Research technicians collect vegetation data to determine the effects of different competition control treatments at the regenerating boreal mixedwood site near Timmins, ON.

Parker's role in the study is to assess the ecophysiology of regenerating spruce and aspen – how the treatments and associated changes in microclimate (light, soil moisture, soil temperature, and air temperature) affect seedling growth and survival. To do this, he is using weather stations to monitor environmental variables and will correlate those data with seedling photosynthesis measurements.

While the spruce seedlings were too small for photosynthesis measurements in 2005, Parker already has some interesting microclimate results.

"Doug has used radial release treatments, which involved removing competition in a circle around individual crop trees, to minimize herbicide use. Our measurements show that these treatments immediately increased the amount of light and moisture available to the spruce crop. Already, we have seen diameter gains in both the spruce and aspen as a result."

Spruce photosynthesis measurements will begin this summer. "Ultimately, we hope that the results of this project will help resource managers to manage boreal mixedwoods to produce increased spruce growth and economic returns," Pitt asserts.

Financial support for this project was provided by the Canadian Ecology Centre-Forestry Research Partnership (CEC-FRP), the Enhanced Forest Productivity Science Program, Grant Forest Products, and Louisiana-Pacific. Other project partners include Scott McPherson, Northeast Science and Information-MNR, who is helping with field work and will communicate results as they become available, and Al Stinson, CEC-FRP.

For information about the ecophysiology aspects of this study, contact Bill Parker (705)946-7424, bill.parker@mnr.gov.on.ca. Details about this project are available on the CEC-FRP website at http://www.forestresearch.ca (click on *Product Catalogue* and *Reports* and look for *Report RP-29*).

Researchers explore how management practices can sink more carbon into Ontario's forests

By Abigail M. Obenchain

Winters are getting milder, summers hotter; glaciers are melting, and extreme weather events are on the rise. These may be the early warning signs that climate change is starting to affect many aspects of the natural world around us. But what can we do about it?

It may appear that climate change is too big for us to tackle, but in truth, as resource professionals, we can play a role in mitigating climate change. So assert Steve Colombo and Bill Parker, OFRI research scientists who recently produced a report entitled *The Effects of Forest Management on Carbon Storage in Ontario's Forests*, published by MNR's Applied Research and Development Branch. The report was coauthored with Nancy Luckai, Qinglai Dang, and Tiebo Cai of Lakehead University in Thunder Bay, ON.

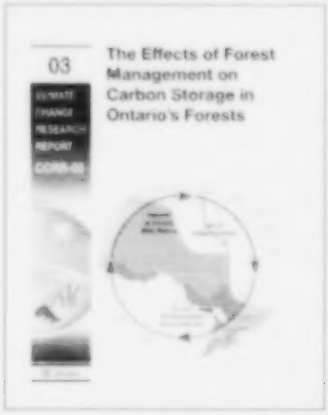
"When most people look at a forest, they see trees. When I look at a forest, I see lots of carbon," Colombo says. "Canada's emissions of greenhouse gases have increased since the country agreed to reduce them to help mitigate climate change. So its going to be harder to meet the targets set out in the Kyoto Protocol."

He continues, "To reduce greenhouse gases such as carbon dioxide, emissions from fossil fuels will have to be controlled. However, the work presented in our report indicates that most forest management activities we could do to increase the supply of wood also help offset emissions from human sources by sequestering or storing more carbon."

The report also states that the Kyoto Protocol allows the Canadian government to decide whether to use forest management to help meet its commitments. Colombo says, "This issue has been receiving input from provincial agencies, including our ministry."

For their study, Colombo and Parker examined 10 important forest management activities: planting/seeding, site preparation, vegetation management, thinning, fertilization, genetic improvement, forest fire management, insect and disease management, road and landing management, and forest harvest.

Estimates of forest carbon were based on the growth of Site Class 2 black spruce in Ontario, modelled using the CBM-CFS2 (*Carbon Budget Model of the Canadian Forest Sector*) model. Stand carbon values used in some of their predictions (which include soil, forest floor, and tree biomass carbon) were generously provided by Werner Kurz, Canadian Forest Service-Pacific Forestry Centre, Victoria, BC.



"For thinning, forest fire management, and insect and disease management, we used information from the scientific literature to make judgments about how they affect forest carbon storage," Parker explains. "For other practices, we were able to use stand yield data and CBM-CFS2 in combination with silvicultural practices information to simulate the effects of these activities on forest carbon storage. We scaled the effect of forest management practices on stand-level carbon up to the provincial level using the amount of area treated with each practice since 1990."

Parker and his colleagues found that all but one activity could be used to increase forest carbon storage during a rotation, either by increasing the rate of carbon sequestration or by protecting or retaining existing stored carbon. "Planting, suppressing fire, and managing insects and disease are all examples of forest management activities that have significant potential to increase carbon storage," he offers. "For instance, in the short term, such as between 2008 and 2012, which is the first Kyoto accounting period, forest fire suppression could help avoid large releases of greenhouse gases that occur when a forest burns.

"Thinning was the exception. It may increase yields over a rotation but does not appear to increase total biomass production or carbon sequestration. However, by reducing sawlog rotation and increasing sawlog quality, even thinning could slightly increase carbon storage if the wood is used for more durable wood products. Wood products that last longer, store carbon longer. And larger sawlogs could be used more to replace materials that result in high amounts of emissions during the manufacturing process, such as steel, aluminum, and concrete."

Parker points out that even paper, which the public might view as being quick to decay, is almost always either recycled or placed in a landfill. "Most of the paper that enters a landfill today will still be there a century from now. It takes a long time for decomposition to happen in a landfill because conditions are mostly *anaerobic* [lacking oxygen]."

"Over the long term, forest management activities can increase both carbon storage and wood supply," he concludes. "Using them appropriately will not only help with climate change but also increase the potential for Ontario's forests to support economically, biologically, and socially important activities."

This report should be of interest to those who are wrestling with policy development related to climate change, Kyoto, or future alternative approaches to mitigate climate change, the two scientists maintain. Parker adds, "It should also prove useful to people interested in the gains in forest growth or wood production that can be obtained from more intensive forest management."

Both researchers say that more work needs to be done on improving our understanding of how carbon cycles through forests and how human activities affect forest carbon storage and release. "Our work is a significant step forward for Ontario's climate change effort, but our estimates are fairly coarse and were based on simplified assumptions about forest productivity," Colombo points out.

He is currently working with two other OFRI researchers, Jiaxin Chen and Michael Ter-Mikaelian, to predict how the province's forest management planning process affects carbon storage.

For more information about this work, contact Steve Colombo, (807)343-4020, steve.colombo@mnr.gov.on.ca or Bill Parker, (705)946-7424, bill.parker@mnr.gov.on.ca. To obtain a copy of *The Effects of Forest Management on Carbon Storage in Ontario's Forests* (Climate Change Research Report No. CCRR-03), phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca.

Hardwood silviculture researchers protect investments in long-term studies

By Lisa J. Buse

While it's not news that forest research is a long-term proposition in the northern hemisphere, just how long it takes to get results may come as a surprise.

"Obtaining meaningful results from long-term research requires substantial ongoing effort on the part of researchers," says OFRI research scientist Bill Cole. "It involves maintaining study treatment and assessment schedules – sometimes for decades, and documenting treatments and data sets – sometimes for use by others who inherit the study after the initiator retires but also to protect study areas from uses that could compromise the research."

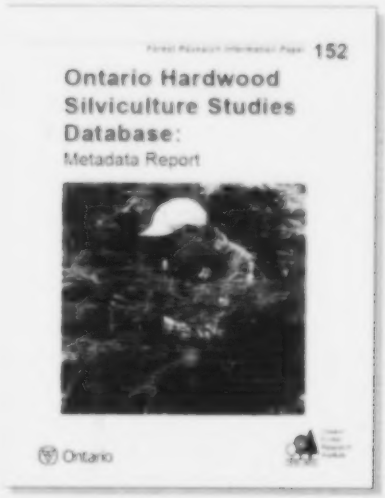
Cole and his fellow hardwood researchers at OFRI are actively pursuing all of these avenues – maintaining, documenting, and protecting established studies – to ensure that those established in central Ontario decades ago produce results well into the future so that resource managers can reap the benefits of those long-time investments.

For example, this past year Cole and his partners began following up on one of longest-running hardwood studies in Ontario. Known as the Parkside Gully study, this tolerant hardwood selection harvesting and product recovery study was established in 1967 by MNR's Mac MacLean and carried on by Harvey Anderson and now Cole to demonstrate sustainable management of sugar maple-dominated stands in the Algonquin Region.

According to Cole, "We conducted the fourth single-tree selection harvest in the stand in 2005, maintaining the 12-year stand entry cycle. Tembec will be processing the harvested wood in early 2006, and we will then be able to quantify the relationship between tree classifications assigned at time of cruising to the net amounts of veneer, sawlog, pulp, and cull. We will also have a complete tally of sawn board dimensions and grades, which will allow us to calculate the total net present values of the harvested wood.

"We hope to show how intensive forest management that is focused on improving quality over the long-term increases not only the quantity of sawn product but also the quality and thus its economic value." He adds, "This was one study that really stood out when we were pulling together all the information about existing hardwood studies in the province and determining which were the most important to revisit."

So what did they do with the hardwood studies information they collected? To ensure that others could follow up on projects of interest, Cole joined forces with MNR's Southern Science and Information (SSI) in North Bay and the Canadian Ecology Centre-Forestry Research Partnership in Mattawa to compile summaries of existing studies and associated databases and publications. They produced these as an annotated bibliography of Ontario hardwood-related research publications and, more recently, a metadata report that provides descriptive information for about 90 ongoing and historical hardwood silviculture studies.



Asserts Cole, "These tools help everyone in the forest management community who is interested in hardwood management to find out what's been done to date, to determine where the knowledge gaps are, and to identify studies that could be reassessed to answer current forest management questions."

Andrée Morneault, vegetation management program leader, SSI, has already put the metadata report to good use. "I was trying to show the relevance of a proposed sugar maple study, and it really helped to have the past study information in one place, especially given that most of the research was done by people who are now retired and would have been difficult to get in touch with."

Protecting these long-term studies is also important. One step is ensuring the study locations are included in the provincial NRVIS (Natural Resources and Values Information System) database so that

Photo: Jeff Kukkis

One of the longest-running hardwood studies in Ontario, the Parkside Gully study is currently focused on a single-tree selection harvest that Algonquin Forestry Authority conducted in 2005, the fourth such harvest since the study's inception in 1967.

resource managers and planners are aware of and protect the plots on Crown land.

However, a more secure system is in place for many of the province's older hardwood research studies, which are located in the Swan Lake Forest Research Reserve. Established in 1950 to study the ecology and silviculture of commercially important hardwood species of south-central Ontario, the Swan Lake Forest Research Reserve encompasses 3,480 hectares of Great Lakes-St. Lawrence Region forest, small headwater lakes, coldwater streams, and a variety of wetlands in the southwest corner of Algonquin Provincial Park.

"The reserve provides a secure, dedicated research forest for both long-term research and related extension activities – a showcase of sorts," Cole says. "As part of ongoing efforts to ensure that the studies established in the area could be maintained, my colleague, Elaine Mallory, and I worked closely with Algonquin Park staff to develop an updated 20-year management plan for the reserve, published in 2005. The plan documents the objectives and planned research, extension, and infrastructure activities for the reserve for 2005-2025; provides standards to ensure activities comply with new park management rules and other relevant policies and guidelines; and serves as a decision support tool for activities in the reserve.

"The 20-year Swan Lake plan is also a strong endorsement by OFRI and Algonquin Park on the value of high-quality long-term silviculture and ecology research in meeting MNR's goal of forest sustainability."

The knowledge base built up on these study areas over the years can also provide a foundation for new initiatives. For example, part of the Swan Lake reserve is one of four field sites (others are Petawawa Research Forest, Kawartha Highlands Signature Site watershed, and Samuel de Champlain Provincial Park) being used for a cooperative project to evaluate the use of high-resolution digital imagery and LiDAR (light detection and ranging) for enhanced forest inventory, in part because multiple layers of data are available over a long period and because crews are there regularly to collect data required for ground-truthing photo-interpreted data.

"This is another example where a long-term protected network of plots pays off for us and our partners," Cole emphasizes.

For more information about hardwood silviculture research projects, contact Bill Cole, (705)946-7408. For a copy of *Ontario Hardwood Silviculture Studies Database: Metadata Report* (Forest Research Information Paper No. 152) or the *Swan Lake Forest Research Reserve 20-Year Management Plan: 2005-2025*, phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca. For details about the Parkside Gully study, visit the *Research* page of OFRI's web site at http://ofri.mnr.gov.on.ca/ofriresearch.cfm and go to *Forest Management and Ecology – Great Lakes-St. Lawrence*.

Did You Know....

FACTS ABOUT OFRI

- The Ontario Forest Research Institute and its predecessor MNR units have been conducting forest research in Ontario for more than 60 years, first from a facility in Maple, Ontario, and beginning in 1990, from the OFRI building in Sault Ste. Marie.
- OFRI's technology transfer unit has an archive that contains at least one copy of nearly every publication produced over the 60 years. Over the last decade, OFRI has received publication requests from across Canada and from more than 40 countries. For more information about OFRI's publications, visit http://ofri.mnr.gov.on.ca/ofripublications.cfm.
- OFRI's primary function is to develop new scientific information and tools to support MNR's forest management policies and guides, planning, and practices. For more information about OFRI research areas and projects, visit http://ofri.mnr.gov.on.ca/ofriresearch.cfm.
- OFRI houses more than 100 MNR staff. About half work in forest research; the others work for MNR units that have responsibility for forest resources inventory and data modelling; terrestrial assessment programs, forest growth and yield, and ecological land classification; Lake Superior fisheries management; the Bear Wise Program; and field communications.
- The expertise of OFRI's research scientists and specialists includes biochemistry, biomass, climate change, ecology, forest health and pathology, forest landscape ecology, genetics, geochemistry, growth and yield, modelling, non-timber forest products, remote sensing, silviculture, and soils and hydrology. For more information about OFRI's researchers, visit http://ofri.mnr.gov.on.ca/ofripeople.cfm.
- OFRI's facilities include three analytical labs – the geochemical, biochemistry, and forest health and pathology labs; three types of greenhouses; controlled-climate growth rooms and chambers; a lecture facility that can hold 50 people; and a 95 hectare arboretum outside Sault Ste. Marie.
- Researchers have access to a 3,480 hectare forest research reserve in Algonquin Park, as well as thousands of research plots in forests across the province.
- For more information about any aspect of OFRI, contact Abby Obenchain, (705)946-7422, abigail.obenchain@mnr.gov.on.ca. You can also visit OFRI's website at http://ofri.mnr.gov.on.ca.

PROFILE

Bill Cole

By Abigail M. Obenchain

Some people like to look at the big picture, but OFRI research scientist Bill Cole finds the *long* picture fascinating.

Throughout his 14-year career with MNR, first as a forest ecology research scientist focusing on forest-lake interactions (1992-1999) and then as a hardwood ecosystem research scientist (1999-present), Cole has been a strong advocate of long-term research.

"It can be difficult to sustain long-term research in an environment where our clients often need quick answers to forest management questions, and the funding changes rapidly from year to year," he says. "However, it's important that we do look at the long term.

"Some trends are difficult to detect, and you have to measure small changes over a number of years to get an accurate picture. Other changes, such as insect and disease infestations or superior growth years, occur infrequently, and if you only collect a few years of data you may miss the trend completely. With silviculture, it may take decades before important and sometimes completely unexpected impacts of management activities show up." (See related article on hardwood studies in this issue.)

Although it's not always easy to maintain long-term research in a government setting, Cole finds his work to be very rewarding. "I think that doing long-term research is actually more difficult in academia, because you have the graduate student model where projects tend to end when the students finish their degree and move on.

"I also really like the applied focus of government research. It's rewarding to know that your results will have a practical impact on resource management, as opposed to just adding to the collective body of scientific knowledge. Our work on hardwood silviculture and forest-lake interactions, for example, supported development of MNR's silviculture guides and fish habitat guidelines."

He concludes, "This is a good time to be a research scientist in MNR. The need for scientific information is very high and was recently reaffirmed by MNR's strategic direction document, *Our Sustainable Future*."

Highlights of Cole's career thus far include:

- With research partner Rich Guyette of the University of Missouri, discovering that some of the logs lying along lake shorelines in Algonquin and Lady Evelyn Smoothwater provincial parks are as much as a thousand years old. "This finding was serendipitous – our goal was simply to better understand wood input rates and natural disturbance along lake shorelines. We found that different tree species behave differently after they die and fall into the lake – white pine, for example, can persist up to 800 years and may float so it can move around the lake, while hemlock is more likely to sink and thus tends not to move.

"It makes you think about whether we should alter wood lying along lake shorelines when those complex structures may have been in place for several hundred years, providing habitat for fish and many other organisms."

- Assembling a meta-database and annotated bibliography of all known hardwood studies conducted in Ontario and renewing OFRI's long-term research relationship with Algonquin Park, culminating in the publication of a 20-year management plan for the Swan Lake Research Reserve (see related hardwood article in this issue).
- Determining that partial harvesting in old growth white pine may provide both ecological and economic benefits (related article in this issue).
- Evaluating a large-scale photography system for plot sampling in Great Lakes-St. Lawrence forests (related article in this issue).
- Providing strong scientific evidence that a log that was in an accused timber thief's possession matched a stump on the victim's property, resulting in the thief's conviction and an OPP Commissioner's Commendation for Cole and four of his colleagues.
- Taking up the reins of a historic sugar maple silviculture study begun in 1967, with the current phase focusing on whether single-tree selection harvesting can be done more often to increase economic output as well as tree growth. Results are expected in 2007.

Photo: Judy Jackson

Research scientist Bill Cole, colleague Elaine Mallory, and former colleague Kim Chapman compare cookies from logs floating along lake shorelines. Cole and collaborator Rich Guyette from the University of Missouri determined these logs may persist for hundreds of years, providing habitat for fish and other organisms.

- And on a lighter note, collecting and preserving large cross-sections or "cookies" from the historic Kirkwood Giant White Pine, which until it blew over in 1997 was the tallest tree in Ontario. Cole created a poster about the tree and then donated cookies and posters to various organizations in the region, such as the MNR District Office and bushplane museum in Sault Ste. Marie, the local museum in Thessalon, Science North in Sudbury, and the Canadian Ecology Centre in Mattawa.

Cole says that a less tangible but equally satisfying highlight is having the opportunity to work with many different partners, such as the Forestry Research Partnership, forest companies, the federal Department of Fisheries and Oceans, the Upper Lakes Environmental Research Network, and most especially, staff with MNR's Southern Science and Information Unit in North Bay and Algonquin Provincial Park.

"Partners are key to maintaining long-term research in an uncertain environment," he asserts. "You can help each other out when times get tough. It provides more stability for projects because if you run out of money or need an extra pair of hands, a partner can step in and take up the slack.

"I am also fortunate to work with top-notch research staff at OFRI, including hardwood ecosystem research analyst Elaine Mallory and research technician Jeff Kokes as well as scientists such as Wayne Bell and Bill Parker."

Away from work, Cole is an aspiring golfer, fisherman, downhill skier, and guitar player. He reports that he spends a lot of time playing board games with his two sons.

If you'd like to chat with Cole about his research, you can contact him at (705)946-7408, bill.cole@mnr.gov.on.ca.

Large-scale photography shows promise for collecting forest inventory and wildlife habitat data

By Abigail M. Obenchain

A few years ago, OFRI research scientist Bill Cole decided to find out if large-scale photography taken in spring and summer from a helicopter hovering 100 metres over the forest could be used to measure how tree crowns grow and develop over time.

"For tolerant hardwood research, we need to know how residual tree crowns change over time in response to partial cutting," Cole explains. "The traditional method for measuring tree crowns is standing on the ground, looking up at the crowns, and using a tape measure and an instrument called a *clinometer*, which measures vertical angles or slopes.

"This method is costly and time consuming because it requires a research crew to go out into the bush and stand under each tree to measure its crown. We're also not sure of this method's accuracy – it can be very difficult to see the entire crown of a tree from the ground.

"A local forestry consulting firm showed me some high-resolution aerial photographs of boreal forest plots taken using a large-scale photography system, which allowed some high-precision measurements to be made. I wanted to find out if this system would work to photograph and measure the hardwood tree crowns on my study plots in the Great Lakes-St. Lawrence forest."

Working with former OFRI researcher Kim Chapman, Cole brought together a bunch of partners – R&B Cormier, WiskAir Helicopters, MNR's Forest Management Branch and Ontario Terrestrial Assessment Program, the Upper Lakes Environmental Research Network, the Forestry Research Partnership, Tembec, Domtar, and the Canadian Forest Service-Great Lakes Forestry Centre – to test this system in the Great Lakes-St. Lawrence forest in Ontario.

"Kim and I were particularly interested in knowing how accurately we could position the helicopter-based cameras over a pre-existing plot centre," Cole says. "We also took the opportunity to test this aerial plot sampling tool for less intensive applications, like plot measurements to support development of forest resource inventories."

The results of their study are detailed in a new OFRI report entitled *Testing Large-Scale Photography to Sample Plots for Forest Inventory in Mixed and Hardwood Forest of the Great Lakes St. Lawrence Region of Ontario*. Among their findings: The large-scale photography system they tested did not target the desired trees well enough to track crown growth over time but may be useful for forest resources and wildlife inventory purposes.

"The average photo was just under nine metres off target, which may be good enough for some applications but is not quite there yet as a tool to measure individual tree crown growth rates from photos taken several years apart," Cole says. "However, we had some very encouraging results and learned quite a bit about what this system is capable of achieving."

He adds that the timing of the spring flights was very good for observing the lower canopy and for identifying tree species. "Poplars were easy to identify in the photos as some had broken bud, and other species' buds were swollen and distinctively coloured. We had over 90 percent success rate in identifying four tree species cohorts: white pine, other conifers, poplar, and other hardwoods, and we were able to identify individual tree species with an average accuracy of 82 percent.

"The spring photos also allowed us to count and estimate decay class for downed wood and snags, which is useful information for wildlife habitat inventory."

The large-scale photos taken during the summer after full leaf-out could allow even more accurate identification of mature trees, Cole says. "But it's impossible to see lower-canopy trees in summer photos, and for our tolerant hardwood research we usually need to be able to measure the understory trees because they represent the future of the stand."

The other drawback of the summer flights over leafed-out forests was the pulse LiDAR altimeter did not always produce a reliable ground signal, making it difficult to calculate altitude. "Without a reliable altitude, we could not accurately determine the photo scale, which compromised height and distance measurements in the associated photos."

Continued on Page 10

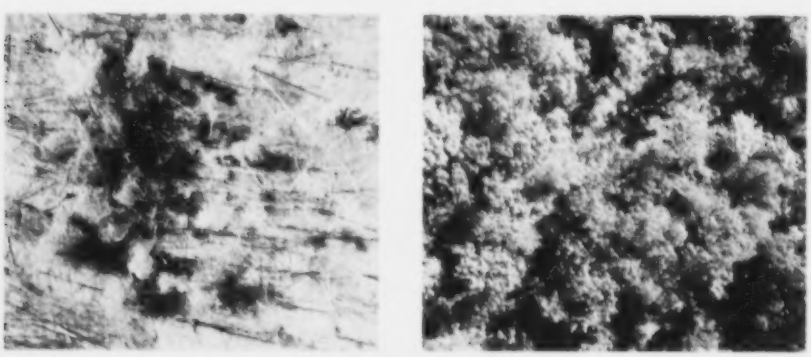


Photo: R&B Cormier Inc. WiskAir MNR

Researchers analyzed large-scale aerial photos taken in spring (before leaf out) and summer (after leaf out) to determine how well they can provide data normally collected by field crews.

Continued from Page 9

Despite these challenges, Cole sees great potential in large-scale photography. "A big concern in today's forestry sector is to reduce risk to field workers collecting data, especially in remote forest sites. LSPs offer a fairly rapid alternative to sending crews out for extended field data collection.

"For large and remote data collection projects, LSP may be more cost competitive for the client as well. It provides a permanent visual archive of the plot, leaves no footprint in the forest, and is easier to audit than a field plot – all you have to do is refer to the original photo, rather than having to send a crew out again. And this system allowed us to get very accurate measurements of tree heights, perhaps even better than ground measurement."

He concludes, "Like many tools in the forest management toolbox, this large-scale photography system is useful for some applications and not for others. It's important to understand its advantages and limitations and to use it appropriately. If you are interested in the use of large-scale photography in collecting data from Great Lakes-St. Lawrence forest stands, I recommend you read our report."

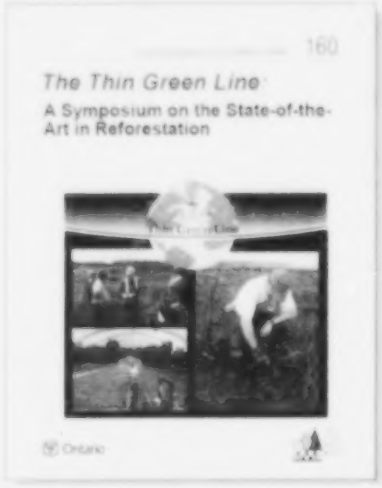
This study was funded by Living Legacy Trust and MNR. For more information, contact Bill Cole at OFRI, (705)946-7408, bill.cole@mnr.gov.on.ca. To obtain a copy of *Testing Large-Scale Photography to Sample Plots for Forest Inventory in Mixed and Hardwood Forest of the Great Lakes-St. Lawrence Region of Ontario* (OFRI Forest Research Report No. 164), phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca.

The Thin Green Line proceedings spotlights regenerating forests

Are you interested in the latest thinking about forest regeneration? Did you miss *The Thin Green Line* symposium, held July 26-28, 2005 in Thunder Bay, ON?

Then you should obtain the proceedings for *The Thin Green Line*, OFRI Forest Research Information Paper No. 160. This publication contains more than 40 papers, each of which falls under one of the following four themes:

- Status of reforestation and afforestation around the world
- Nursery methodologies to produce target seedlings
- Planting and planting site treatments to optimize regeneration
- Enhancing timber production and non-timber values through stand establishment



According to OFRI research scientist and symposium cochair Steve Colombo, the symposium drew forest researchers, educators, forest industry workers, policymakers, and concerned citizens from Canada, the United States and as far away as Finland, Sweden, Italy, and Japan. They came discuss, learn, and find possible solutions to stand establishment problems.

"This event drew on developments in reforestation from Scandinavia and southern Europe but had a North American focus," he reports. "A lot of good information and many new ideas were discussed."

According to Wayne Fiset, manager of OFRI and a conference participant, "This conference was a good example of how researchers, policymakers, and field foresters can work together to focus on common issues and solutions."

To order this publication, phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca.

OFRI Forest Research Trivia

1. How far north does research geneticist Pengxin Lu recommend moving white pine seed to maximize growth and decrease risk of frost damage, based on a white pine genecology study he conducted?

Answer: One degree latitude north. His work found that trees from seeds from more southerly and warmer areas grew faster; however, moving seed too far north increased the risk of frost damage. This information may be useful to those considering where to plant white pine in light of Ontario's changing climate. For more information, see *Seed Source Selection of Eastern White Pine*, OFRI Forest Research Note No. 64; to obtain this publication, phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca.

2. According to research conducted in ice-damaged maple sugar bushes in eastern Ontario after the 1998 Ice Storm, what is the maximum percent of crown damage that sugar maples can sustain without limiting their growth and sap production?

Answer: 50 percent, says research scientist Tom Noland, who studied effects of the ice storm on maple sugar bushes. "And if your maples lose more than 75 percent of their crowns, go ahead and tap them fully because they aren't likely to survive." For publications about this research, visit OFRI's *Publications* page at http://ofri.mnr.gov.on.ca/ofripublications.cfm and search for *Ice Damage*.

Can partial harvesting benefit old growth white pine stands?

By Abigail M. Obenchain

Researchers investigating partial harvesting in old growth white pine stands in the Algoma District of Ontario have come up with some surprising and interesting results, says Bill Cole, study lead and research scientist with OFRI.

The study began back in 1992, when the former Lajambe Forest Products Ltd. approached the Ministry of Natural Resources (MNR) District Office in Sault Ste. Marie with a proposal to partially harvest white pine in areas north of Searchmont that were being considered for conservation as old growth but were still available for harvest.

"The idea was to conduct the harvest in such a way that some old growth values were retained," Cole says. "At that time, there were no guidelines for partial harvesting of old growth white pine.

"So the district, the company, and staff with MNR's Southern Science and Information developed a prescription for select stands that specified extracting some commercially valuable white pine timber and leaving some sound old growth white pine as well as some poor-quality, declining old white pine to provide a future source of large-diameter downed coarse wood [logs] for wildlife habitat."

The harvest took place in 1992, and in 2001, Cole and partners at the University of Toronto and Dalhousie University obtained a grant from MNR's Ontario Living Legacy program to collect data in 12 harvested stands as well as six comparable uncut stands to determine whether the harvest had met its objectives. Here's what they learned:

- Harvest targets were met: Half of the white pine basal area was removed, including equal amounts of *AGS* (acceptable growing stock – trees with a high probability of maintaining or increasing their commercial value until the next harvest) and *UGS* (unacceptable growing stock – trees of poor quality or high risk with a low probability of surviving or improving before the next harvest) trees, which opened up the white pine "super canopy," which was 30+ metres tall. (The stands also had a 15+ metre lower canopy of mostly poor-quality mixed hardwoods and conifers.)

  Typically a greater proportion of UGS trees would be harvested to improve stand quality, but in this case leaving more of them was critical to meeting old growth and wildlife habitat objectives. "Between 1992 and 2001, the number of standing dead trees did not change significantly," Cole says. "That means that the harvest successfully retained that important old growth attribute."
- Wildife cavities were more common in standing dead trees than in living trees, in larger trees – whether living or dead, and in white pine trees. "White pine had far more cavities than all other tree species combined, and 68 percent of cavities in standing dead white pine showed signs of excavation by animals," Cole reports. "Only 10 percent of cavities in standing dead trees of other species were of animal origin. This provides empirical evidence that wildlife prefer white pine."
- Harvested stands had significantly more downed coarse wood than uncut stands, because the harvesters cut many trees that were *cull* (had no commercial value due to disease and decay). "What this tells us is that loggers have a lot of difficulty identifying cull trees before they cut them," Cole says. "This is unfortunate ecologically, because it results in a single large pulse of coarse wood onto the forest floor at one time, when it would be better if it happened gradually. Economically, it's a waste of time and money to cut trees you aren't going to use. Improving loggers' ability to detect cull trees is an obvious science need."

Photo: Bill Cole

Former University of Toronto researcher Dan Bebber uses a laser hypsometer to measure tree distances from plot centres for a study on partial harvesting in old growth white pine stands in Algoma District.

Continued on Page 12

Continued from Page 11

- Harvested stands were not significantly more susceptible to windthrow. "It is widely thought that thinned old growth pine stands, with large trees on relatively shallow rocky soils, are not very stable, and if you open the stand up, the trees that are left will be more susceptible to windthrow," Cole explains. "We saw very little evidence to this effect. The trees in our harvested stands still appeared to be very stable after nine years."
- Old white pine responded well to thinning, with up to 60 percent increases in diameter growth over eight years, compared with at most 10 percent in the uncut stands. "Conventional wisdom says that old growth white pines are past their prime and won't respond to reduced competition. Our study provides evidence of significant diameter growth increase in large old pines, even after baseline growth of uncut stands was taken into account." He adds, "More study of the distribution of new growth on the tree stem, from stump to crown, is needed because some of the diameter growth could be due to buttressing – adding wood near the base in response to increased wind stress."
- White pine did not regenerate successfully in either the cut or uncut stands. "The harvested stand had slightly more white pine regeneration, but it was not evenly distributed," Cole says. "This result is not surprising given that planned site preparation [mechanical scarification] did not occur in the year following the harvest and to the fact that the relatively dense lower canopy layer was not thinned. Our study confirms that white pine will likely not regenerate naturally in old growth stands without proper soil scarification and overstory density regulation."
- Logging damage was in the six to seven percent range, slightly higher than the provincial standard of five percent. However, Cole points out that the harvesters were working around very large diameter trees and on difficult terrain, so the amount of damage was probably commensurate with the conditions.

"This study challenges some of the conventional wisdom about managing old growth white pine," Cole concludes. "It shows that we can use silviculture to produce some benefits in mature or older white pine stands, such as producing larger trees sooner and enhancing wildlife habitat.

"However, more research is needed to determine how to ensure successful natural pine regeneration and to reduce residual logging damage when conducting partial harvests in old growth white pine stands."

For more information about this study, contact Bill Cole at OFRI, (705)946-7408, bill.cole@mnr.gov.on.ca. To obtain reprints of two related journal articles, entitled *Diameter Increment in Mature Eastern White Pine* Pinus strobus *L. Following Partial Harvest of Old-Growth Stands in Ontario, Canada* (from *Trees*) and *Effects of Retention Harvest on Structure of Old-Growth* Pinus strobus *L. Stands in Ontario* (from *Forest Ecology and Management*), phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca.

Using prism sweeps to sample downed coarse wood

While studying partial harvesting in old growth white pine stands, researchers developed a new technique to use a wedge prism and a variable radius plot design to sample downed coarse wood. This technique allowed them to use the same instrument to measure downed and standing wood volume at temporary forest sampling points.

For more information, see the journal paper entitled *Prism Sweeps for Coarse Woody Debris* (*Canadian Journal of Forest Research*), reprints of which are available from OFRI.

What's new at http://ofri.mnr.gov.on.ca?

A new feature on the OFRI home page is a quick link to more than 25 OFRI research profiles, including six new ones on projects such as taper equations for plantation-grown jack pine and black spruce, soils-related Fluxnet Canada research, research on natural fire regimes to assist with emulating natural disturbances, and more.

Visit OFRI's website today to read these profiles and get access to a wealth of information about OFRI's research and products.

Read an OFRI publication recently? What do you think of it?

Another new feature on OFRI's website is a quick link to a publications feedback form. We want to know what you think about our publications, and this form allows you to give us feedback quickly and easily. So if you've read an OFRI publication recently, visit http://ofri.mnr.gov.on.ca and let us know your thoughts!

Sign up for the *Insights* e-mailing list!

Just send your name, title, organization name, and e-mail address to information.ofri@mnr.gov.on.ca. You will receive short, easy-to-read e-bulletins every month or so with the latest news on OFRI research and products. Sign up today!

We promise not to share your contact information.

Fighting white pine blister rust through tree improvement

By Abigail M. Obenchain

Eastern white pine is an important tree species, especially in central Ontario: Its light, strong wood is highly valued, and it plays an important ecological role, particularly for wildlife habitat (see related article on partial harvesting in this issue). It is the most stately inhabitant of Canada's eastern forests, with some specimens growing more than 40 metres tall and living more than 250 years.

Unfortunately, white pine blister rust, an imported disease that crossed the Atlantic from Europe around 1900, has contributed to a steep decline in eastern white pine across its range in Ontario. Because eastern white pine did not co-evolve with blister rust, it has little natural genetic resistance to fight this disease. Under certain conditions, blister rust can kill every white pine seedling growing in a natural stand or plantation, with some areas having higher blister rust risk than others.

This fungus is particularly deadly to seedlings because its spores land on needles first, then germinate and spread quickly to the main stem, producing cankers, disrupting nutrient flow, and quickly girdling and killing the young trees. Older infected trees may live a long time with the disease, but it may kill their tops or branches, causing deformity and weakness and attracting pests and other disease agents.

Nearly 60 years ago, pioneering MNR genetics researcher Carl Heimburger began a quest in Ontario, Quebec, and the United States for wild white pine trees that showed some resistance to blister rust. His search did turn up some trees with resistant traits, and he conserved their genotypes (individual genetic constitutions) by planting them in genetic archives in southern Ontario (see related article in this issue).

Other researchers such as Louis Zsuffa and George Buchert continued this work over the years, and five years ago, OFRI's newly hired research geneticist Pengxin Lu picked up the reins.

"Breeding for blister rust resistance is a complex process, with many steps," Lu says. "We started the latest phase in this work in Ontario by collecting open-pollinated seeds from white pine trees whose genetic history we had records for and using them to produce seedlings. In addition, we collected blister rust spores in the wild and propagated black currant seedlings, because blister rust cycles back and forth between currant and other *Ribes* species and white pine. In other words, to produce spores for inoculating white pine, we first had to infect currant plants.

"After the white pine seedlings were inoculated with spores from infected currant plants at six to 12 months of age to produce a nearly 100 percent infection rate, we closely monitored disease progression and recorded which seedlings died – which was most of them. However, some did survive, and we took these and produced more seedlings by taking cuttings and rooting them, which was a challenge in itself as traditionally conifers have been difficult to propagate through rooted cuttings [see *Insights* Vol. 6, No. 2].

"These half-sib white pine families selected after blister rust inoculation and survival tests were outplanted in three locations with varying climates – Thunder Bay, Sault Ste. Marie, and Midhurst – to determine how well they can survive and grow outdoors. Throughout all these steps we have been keeping careful records or *pedigrees* that show the genetic history of each individual seedling, a step that is critically important in studying the inheritance of blister rust resistance and in evaluating the genetic worth of each individual for future use."

He continues, "Over the past five years or so we have conducted six rounds of inoculations with about 15,000 seedlings screened, and we are

Continued on Page 14

Photo: Bob Sinclair

Research geneticist Pengxin Lu conducts controlled pollination of blister rust-resistant white pine at the OFRI arboretum.

Continued from Page 13

very pleased with the results. We have identified eastern white pine families with stronger partial resistance to blister rust as evidenced by fewer infection spots, slower disease progression after infection, and higher survival rates. These families could be grown on sites with moderately high risk of blister rust.

"We have also developed what we call the third-generation (F3) backcross interspecific hybrids, which means we've crossed eastern white pine with another species to produce seedlings," Lu continues. "These trees are about 87.5 percent eastern white pine, with the rest of their genome from Eurasian white pines.

"We have found these hybrids to be highly resistant to blister rust but need to determine how they will grow in Ontario's climate. These have also been outplanted so we can monitor their cold hardiness and growth performance. Long-term field trials that have run for 30-40 years in southern Ontario indicate that some white pine interspecific hybrids grow faster than eastern white pine with equal to slightly higher wood density."

Lu and his colleagues were particularly pleased that the resistance genes transmitted reliably during the cross-breeding. "Within five to 10 years, we hope to have a fourth generation of hybrids whose genome is about 94 percent eastern white pine with major resistance genes from the Eurasian white pines. Of course, we are also very encouraged by the strong partial bluster rust resistance shown by some of our native white pine genotypes."

If these trees do well after outplanting, they can be propagated vegetatively for commercial use, Lu says. The final step will be to establish seed orchards for commercial production of seeds that will grow into trees that are resistant to blister rust.

Lu points out that many researchers across North America are looking at finding and breeding resistance among the continent's five-needled pines (western white pine, sugar pine, whitebark pine, etc.), all of which fall prey to blister rust. "We are collaborating with these other research programs, particularly those associated with the Canadian Forest Service's Pacific Forestry Centre and the USDA Forest Service," he says. "We share information and genetic material and help each other with training on subjects such as spore production and inoculation."

With all of the work that is going on across the continent, Lu is hopeful that in the future their efforts will help restore the North American white pines to their former glory in the ecosystem.

Other partners in the white pine blister rust resistance project include MNR's Northwest Science and Information and Kemptville District Office.

For more information, contact Pengxin Lu, (705)946-7415, pengxin.lu@mnr.gov.on.ca. To obtain a reprint of a 2005 *Forest Ecology and Management* article entitled *Seedling Survival of* Pinus strobus *and Its Interspecific Hybrids After Artificial Inoculation of* Cronartium ribicola, phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca.

A note about Bob Sinclair ...

OFRI manager Wayne Fiset would like to pay special tribute to recently retired senior research technician Bob Sinclair, who was a champion on behalf of MNR's genetic archives throughout his career with the institute.

"Looking after both the genetic archives on the ground and the 60 years worth of paper records back at the office takes a lot of tedious work," Fiset notes. "It is not glamorous, and it doesn't directly result in publications or profile.

"But it is critically important to ensuring that the many years of investment in genetics research aren't lost. Too often, when researchers leave, their work is mothballed and never again sees the light of day. The dedication and hard work of Bob Sinclair over the past 15 years has helped to protect the important legacy of researchers such as Carl Heimburger and Louis Zsuffa for future generations of researchers to use and build on. We, the managers and colleagues of Bob Sinclair, can't thank him enough for his efforts in this area."

Ministry of Natural Resources
Lifetime Achievement Award
Robert (Bob) Sinclair
April 28, 2006
For a public service career
dedicated to genetic conservation
and forest resource management in Ontario

To show their appreciation for his significant contributions to protecting MNR's genetic resources, Bob's colleagues nominated him for an MNR P.R.I.D.E. Lifetime Achievement Award, which he received in April 2006, shortly before retiring.

MNR's genetic archive touted as one of the world's best "living libraries" of tree genes

By Abigail M. O'Brenchain and Faye Konopelky-Pelletier

Over the past 60 years, MNR researchers have invested a lot of effort into genetic archiving, and according to recently retired senior research technician Bob Sinclair, who devoted much effort over his career to protecting these archives, they are among the best in existence. Read on to learn more about these valuable research resources.

What is a genetic archive?

"A genetic archive is a living library of genetic material," Sinclair explains. "If you walked through an archive, at first glance you'd probably think you were walking through a typical tree plantation. In a genetic archive, however, each tree is labelled and numbered and cross-referenced to a paper or electronic file that describes the genotype [genetic makeup] of that tree and related research that has been conducted on it over the years. Perhaps it has shown resistance to a particular disease, tolerates drought well, or grows unusually fast."

How are archived genotypes used in research?

According to Sinclair, OFRI's genetics researchers use trees in a genetic archive for controlled breeding, to produce seeds that will grow into seedlings that will hopefully have a desirable genetic trait, such as resistance to white pine blister rust (see related article in this issue).

"If researchers are trying to produce white pines with improved disease resistance, they find trees in the genetic archive that our records indicate have a history of genetic resistance to disease and apply pollen from pines from other locations that also have disease resistance," he says. "After applying the pollen, they cover the flowers with special isolation bags to ensure pollen from other trees in the area doesn't blow onto the flowers. The resulting seeds should produce seedlings that have the desired genetic trait."

The trees in archives are usually clones, which are produced by taking mature scions (cuttings) from trees that have desirable genetic traits and grafting them onto native rootstock. This procedure produces small but sexually mature trees quickly.

Photo: OFRI Genetics Program

OFRI's genetic archives allow controlled breeding of trees with known genetic traits such as superior growth or disease resistance.

It all began with Carl Heimburger ...

According to Sinclair, the trees in MNR's genetic archives contain a diversity of genetic material for white pine, red pine, hybrid poplar, spruce, and many other species, both native and exotic. For example, from the late 1940s to the early 1960s, renowned MNR genetics researcher Carl Heimburger looked for white pines with resistance to blister rust and experimented with cross-breeding white pines with related pines from other parts of the world.

Heimburger was followed by Louis Zsuffa, who conducted some white pine genetics research but focused mainly on breeding hybrid poplar as part of a major effort to increase biomass production on abandoned farmland in southern Ontario.

MNR's first genetic archive, established in 1948 in Maple, Ontario, started with white pine genotypes as part of a blister-rust resistance experiment. Creating multiple archives is important as forests can be lost through fire, a change in land ownership, or municipal expansion; thus, MNR researchers established other archives in southern Ontario locations such as Mellancthon, Allendale, Orono, and Turkey Point and most recently, at OFRI's Arboretum in Sault Ste. Marie.

The southern Ontario locations are useful because the relatively mild climate poses little threat to these valuable trees, Sinclair says. Although some species planted at the Sault Ste. Marie archive site are less likely to survive due to the harsher climate, its location close to OFRI makes it much cheaper to maintain and use.

MNR's archives: Among the cream of the crop

"MNR does have one of the best genetic archives in the world, in terms of species and genotype diversity," Sinclair asserts. "Plenty of other archives have beautiful trees but no records. We have the trees and the identification records, going back up to 60 years. You must have both the tree and the record; one without the other renders the research data and historical significance worthless. MNR has a significant, long-term investment in genetics research and its archives, and it's still viable: The genotypes are available for others to access and use."

Are MNR's genetic archives in danger?

The biggest threat to these archives, Sinclair reports, is the fact that some are no longer under OFRI's control. "For example, after MNR closed its research facilities in Maple, the land was sold to the city of Vaughn. The archives are safe for the time being, but if the city chooses to develop the land, the archives could be destroyed. The archives near Turkey Point are now part of the St. Williams Conservation Reserve and the only large area of Crown land for miles; thus, the archives in this park could be damaged by heavy use such as dirt biking, or future research could be curtailed due to management plan changes.

"We have spent, and my genetics colleagues at OFRI will continue to spend, a lot of time meeting with and educating the people currently responsible for the land on which the archives are located to ensure they understand how valuable and scientifically important they are," he says. "We feel it's necessary to make sure that these genetic resources, in which MNR has invested so much over the past 60 years, remain protected for future generations to benefit from."

For more information about MNR's genetic archives, please contact Pengxin Lu, (705)946-7415, pengxin.lu@mnr.gov.on.ca.

Stemming red pine decline in southern Ontario

By Abigail M. Obenchain

Red pine plantations are abundant in southern Ontario, particularly in the infamous former blowsand areas. Farming practices of the mid- to late 1800s degraded these areas into virtual deserts, so many red pines were planted during the 1920s and '30s in hopes of jumpstarting ecological recovery. This strategy works: The deserts are gone, replaced by thriving forests that provide many benefits to the people of southern Ontario. However, now some of the forests are facing a new peril.

"Unfortunately, in some of these plantations, most of which have been well managed over the years, maturing red pine trees that were expected to live at least 100 years are now dying at unprecedented rates," reports OFRI research scientist John McLaughlin. "It's a very serious problem.

"For example, Simcoe County, with an annual income of $1 million from its plantations, is losing valuable sawlog and pole-sized timber. In the Region of York, tall trees, many of them still with green needles but with rotten roots, are blowing down, creating hazardous conditions for the many recreational users of these forests.

"The rapid collapse of red pine plantations can have ecological consequences as well. Forest managers want these plantations to be converted gradually to native oak-dominated mixedwoods, but if red pine losses cause large holes in the canopy to develop quickly, then less desirable, opportunistic species like Manitoba maple and raspberry will likely move in and dominate these sites."

He continues, "We knew that many biotic and abiotic factors could be contributing to this decline: extreme weather events such as drought, increases in average temperatures, root diseases, insect outbreaks, soil characteristics, and other factors. So we set out to determine what key factors are driving this decline, if and how they are working together, and how we could change management practices to prevent or minimize such decline."

This research is taking place on 12 sites across central and southern Ontario, from the Gurd Experimental Forest near North Bay to a site near Delhi (southwest of Brantford). McLaughlin says, "We have collected all of the data we need to compare healthy and declining stands, such as information about soil characteristics, basic mensurational data [diameter at breast height, tree height, age, etc.], foliar nutrient levels, root depth and distribution, mycorrhizal colonization, precipitation and temperature, and pathogens present.

"We are doing a final data collection and experiment this spring to look at how soil organisms may stimulate development of *Armillaria*, a common cause of root rot disease. Our sites vary greatly with regards to rhizomorph production and virulence, and we hope to find out whether this variation is due to the individual fungi or to something at the site."

Photo: Dan Dey

Southern Ontario's red pine plantations are a source of high-value timber and provide recreational opportunities to many; their rapid decline could hinder efforts to convert these plantations to natural forest.

While data are still being analyzed, some interesting preliminary results have come to light. "One thing clearly separates healthy sites from the diseased sites we have observed," McLaughlin says. "The pH of the C horizon is slightly acidic on the healthy sites, while soils on the diseased sites are very alkaline. This finding ties into drought resistance – red pine don't like to grow their roots into highly alkaline soil, and shallower root systems result in decreased ability to access water during droughts."

And drought has become increasingly common in the areas where these plantations are growing, McLaughlin points out. "We suspect that this is a climate change issue. Over the next 100 years, the optimal climate for red pine could move 300 kilometres north, meaning we should think very carefully about where we plant red pine today. Though red pine are very drought resistant – that's why they were planted in the blowsand areas in the first place – they can still succumb if their roots are too shallow or have been killed by root disease such as Armillaria."

He adds that *Armillaria* is one of the most serious pathogens in Ontario. "It's very opportunistic – it is present on most sites at a sub-lethal level, and then when the host is stressed due to drought or some other factor, it takes off, and you end up with an irreversible decline."

McLaughlin's investigations have also expanded awareness of the extent of another serious red pine disease, Annosus (Fomes) root rot. "We've known since the mid-1950s that this virulent pathogen was present in Ontario, but I came across it on many sites where it had not been recorded before. Although it does not seem to be as widely distributed as *Armillaria*, it is a more virulent pathogen, even when the trees are not stressed."

Once all the data are analyzed, McLaughlin hopes to have the intricate web of factors involved in the red pine decline sorted out so he can then collaborate with plantation managers in generating strategies to minimize current and future losses in economic, scenic, and ecological values.

For more information about this project, contact John McLaughlin, (519)824-4120, ext. 54849, john.mclaughlin@mnr.gov.on.ca.

DNA analysis of fungi arrives at OFRI

By Abigail M. Obenchain

Armillaria root rot disease is clearly an instigator in the red pine decline that's on the rise in central and southern Ontario, asserts OFRI research scientist John McLaughlin.

However, *Armillaria* species vary considerably in their virulence: One species may kill; another may dwell on a site but not cause serious damage. To protect valuable timber resources, researchers must determine which fungi species cause the most damage and what sites, conditions, and tree species they prefer.

Sometimes fungi can be identified on the ground if fruiting bodies (mushrooms) are present; however, usually fungi work covertly inside the tree or on roots below ground, requiring researchers to tease out their identity in a laboratory.

The traditional method for identifying fungi is to culture samples of diseased wood in a Petri dish, removing and re-culturing just the fungus, viewing the new culture under a microscope, and using complex dichotomous keys to determine what species it is.

"This can sometimes take months to do," McLaughlin says, "and the keys can be very subjective. For example, a key might describe a surface as 'somewhat rough.' The difficulty is that something that's looks somewhat rough to me might not seem somewhat rough to you."

Enter molecular identification of fungi or DNA analysis. (DNA, or deoxyribonucleic acid, is the molecule within cells that carries genetic information; like fingerprints, DNA is unique to each species and individual.) McLaughlin is currently working on his PhD at the University of Guelph and has learned to identify fungi by isolating, replicating, and analyzing key segments of their DNA.

Photo: Trudy Varhinen

Forest health and pathology lab supervisor Glenna Halicki Hayden (right) demonstrates DNA extraction from tree decay fungi to summer experience student Jaela Knudsen.

This technique will provide researchers with a more efficient and effective method of identifying fungi that cause tree diseases, allowing them to respond more quickly to forest managers who need information about how to change their management practices to minimize disease-related losses.

McLaughlin recently spent two weeks at OFRI to transfer some of his new knowledge about identifying fungi through their DNA to his colleagues, pathology research forester Sylvia Greifenhagen and pathology lab supervisor Glenna Halicki Hayden.

He hopes to use this technique in ecological studies and in identification of *Armillaria* species that are attacking stressed red pines across southern Ontario, causing significant timber losses, affecting highly valued recreation areas, and interfering with efforts to convert red pine plantations to natural forest (see related article in this issue).

Still available:

Vegetation Management Alternatives: A Guide to Opportunities.

Get your hands on this very useful and handy binder today! You can either phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca.

Tools can help to estimate decay in living trees

By Lisa J. Buse

Knowing the amount of wood decay, commonly referred to as *cull*, in trees is important for estimating current and future wood supply. Ontario's cull tables were developed prior to the 1960s and have information gaps, particularly for plantations, overmature stands, and mixedwoods.

So when MNR's Forest Growth and Yield Program was searching for an effective, economical way to fill these gaps, Sylvia Greifenhagen, OFRI's pathology research forester, stepped in.

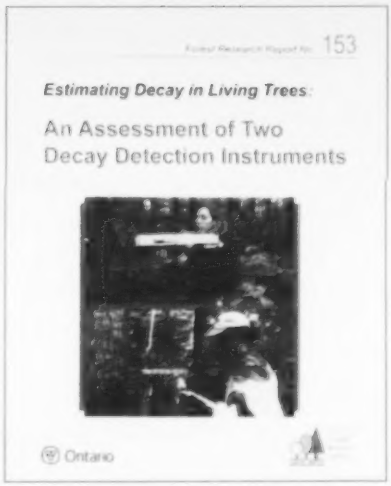
"Wood decay is caused by fungi that degrade and metabolize cell walls, thereby reducing the structural strength of the wood," Greifenhagen says. "Because decay occurs inside the tree, often only affecting the heartwood, it can be impossible to tell if or how much of a tree is decayed by looking at the outside.

"This study was an opportunity to develop estimates of internal decay using new electronic power tools. With financial support from the Canadian Foundation for Innovation and cooperation from St. Mary's Paper and Domtar, we tested two different decay-detecting devices on sugar maple and aspen."

And how well did the tools work? "One device was faster, but the other worked better for hardwoods, so it's best to know the intended use before choosing among the available devices," Greifenhagen emphasizes.

"Both were reasonably accurate, compared with measuring decay visually at the ends of cut logs. Their major advantage is that they can be used on live trees, rather than cutting and sectioning trees to measure decay. These tools are often used by urban foresters to identify hazard trees.

"Like other technologies, decay-detecting tools are advancing rapidly, and better ones than those we tested are already available. Using these new decay-detecting devices will move us one step closer to improved decay estimates for the different kinds of forests and forest stands we have in Ontario."



For more information about the decay detection project, contact Sylvia Greifenhagen at (705)946-7411. To obtain a copy of *Estimating Decay in Living Trees: An Assessment of Two Decay Detection Instruments* (Forest Research Report No. 153), phone (705)946-2981, ext. 271, or e-mail information.ofri@mnr.gov.on.ca.

What do we know about northeastern Ontario aspen stand dynamics following forest tent caterpillar defoliation?

By Lisa J. Buse

"Not enough," says OFRI researcher Rongzhou Man.

Trembling aspen, which is an increasingly important commercial tree species for forest industry in Ontario, is thought to be in decline in northeastern Ontario. Man indicates that "this decline is most likely due to a combination of unusually frequent forest tent caterpillar outbreaks combined with a drought that lasted most of the 1998 growing season."

He continues, "We are concerned that the longer-term dynamics of this species, commonly used for pulp and composite lumber products, may be affected. Aspen has advantages over other boreal tree species in that it grows relatively quickly and costs little to regenerate. But widespread decline and mortality in these aspen stands could alter the *succession* – the change from one plant community to another over time – of these forested areas, as well as the supply of fibre for northeastern Ontario's mills."

In 2005, Man and provincial forest entomologist Taylor Scarr of MNR's Forest Health and Silviculture Section (FHSS) began a project near Kapuskasing and Hearst to determine the early dynamics of the declining aspen stands following repeated forest tent caterpillar-related defoliation and decline.

According to Scarr, "Over 500,000 hectares of aspen mortality were mapped by the MNR-CFS forest health program. This project will help forest managers to better understand the dynamics and succession of aspen stands following forest tent caterpillar defoliation in support of better forest planning and forest management practices that emulate natural disturbance by insects."

For more information about this project, contact Rongzhou Man, OFRI, (705)946-7484, rongzhou.man@mnr.gov.on.ca or Taylor Scarr, FHSS-MNR, (705)945-5723, taylor.scarr@mnr.gov.on.ca.

OFRI STAFF NEWS

Congratulations to the following staff ....

- **All MNR staff who work at the Ontario Forest Research Institute**, which received the 2005 Sault Ste. Marie Chamber of Commerce Environment Award for showing exceptional environmental awareness in operating the building and contributing to protecting the environment through research and community programs.

- Research scientist **Tom Noland**, who received the 2005 Fruchter Award from the Upper Lakes Environmental Research Network in recognition of collaborative efforts for his Canada yew research.

- Research scientist **Bill Cole**, research analyst **Elaine Mallory**, and research technicians **Kevin Maloney, Darren Derbowka,** and **Jeff Kokes**, who received commissioner's commendations from the Ontario Provincial Police for their use of tree ring analysis to support an illegal logging conviction. Through tree ring analysis, Cole and the others were able to prove that a butt log found on the defendant's property matched a stump on the victim's property, strengthening the Crown's circumstantial case.

Bill Cole, Darren Derbowka, Elaine Mallory, and Kevin Maloney at the OPP Awards. Not pictured: Jeff Kokes.

- Graphic designer **Trudy Vaittinen,** who received a special MNR P.R.I.D.E. Spirit of Recognition Citation for her painting of an aerial moose survey to honour the four MNR staff lost in a helicopter accident near Sault Ste. Marie in January 2003.

Trudy Vaittinen with award nominator Paul Glassford.

Welcome to ...

- **Dan Puddister**, who will come aboard as OFRI's new science management coordinator on June 5, 2006. He has worked for the MNR for the past 17 years since graduating with an honours bachelor of science degree from the University of Guelph. In 1988, Dan joined MNR's Forest Management Competency program as a senior biologist and became the program's coordinator in November 2001. Prior to that, he worked in several MNR districts and regions as a biologist assessing and managing fish and wildlife populations and habitats.

Dan says, "I'm very excited about joining OFRI and look forward to supporting the staff in achieving their scientific and personal goals. I look forward to the challenges and opportunities presented in MNR's new science strategy and the development and implementation of OFRI's new strategic plan. I'm eager to learn more about the research projects staff are working on, and I am particularly interested in advancing the evolving relationship between MNR policy and science."

- **Lorie Gill**, new administrative assistant to Wayne Fiset, manager of forest research and development at OFRI. Lorie's previous position was with MNR's Northeast Science and Information in Timmins.

Farewell to ...

- **Bob Sinclair,** who retired in April 2006. Bob worked for MNR for more than 30 years in various locations around northern Ontario. He fought fires, helped plant millions of trees in Timmins District, worked on the spruce science program under MNR's old Northern Forest Development Group, and spent 16 years working with various genetics projects at OFRI (see article about MNR's genetic archives in this issue). He reports he is looking forward to spending more time curling, cross-country skiing, and woodworking.

- Administrative staff **Heather Wreggitt** and **Shirley Middleton**, both of whom who retired in fall 2005 and are looking forward to spending more time travelling around Canada and the United States.

- Science management coordinator **Vivienne Scott**, who left in January 2006 to become acting manager of MNR's Forest Business and Economics Section.

biomass for biofuel

Question: How can converting unused forest biomass to biofuel improve silviculture in Ontario?

Wayne Bell

Answer: According to OFRI research scientist Wayne Bell, Ontario's managed forests have two plentiful sources of biomass for producing biofuels or other products: non-commercial trees and slash. And, he contends, making use of these resources will improve Ontario's silviculture efforts.

"During harvesting, operators often leave behind non-commercial trees such as balsam poplar and birch and other hardwoods with poor stem quality," Bell explains. "These trees, often referred to as *residuals*, can make up a significant proportion of the future stand. When trees are left behind because they have poor form or are diseased, and natural regeneration is being relied on, leaving some poor-grade trees may maintain genetic diversity.

"However, leaving too many may result in future stands with poor genetic stock. Estimates indicate that on some prime sites in Ontario, these non-commercial trees can take up 20 percent or more of the landbase. These trees may contribute to wildlife habitat in a limited way, although balsam poplar is not a preferred wildlife tree, but having them occupy growing space may not be the most productive use of these sites.

"In addition, trees and downed wood left behind can make it difficult for post-harvest operators to manoeuvre their mechanical site preparation equipment, resulting in less plantable area. This commonly reduces the number of trees planted.

"As a case in point, most trees are planted about 1.8 metres by 1.8 metres, which is 3,000 stems per hectare; however, it is not uncommon to plant only 2,400 stems per hectare because of a lack of plantable microsites.

"Residual trees also dictate that aerial spraying must occur above the tops of the trees, necessitating wide buffers to protect sensitive values from possible drift. The closer to the target herbicides can be released, the smaller the required buffer, which means more plantable area.

"Then there are the roadside slash piles – branches and other wood not taken to the mill, which also occupy valuable space, in this case, right next to the road system. Again, these can provide valuable wildlife habitat, as small mammals are quick to set up residence in the piles. Burning slash piles has been a common practice in Ontario but has resulted in at least one temporary closure of a mine due to air quality issues, and insurance companies are becoming more reluctant to insure operators who do it because of liability related to starting forest fires."

Bell concludes, "Using non-commercial trees and slash for biofuels will not only provide a source of renewable energy for the people of Ontario but also has the potential to contribute positively to silviculture, by helping improve stand quality, the ability of operators to move safely around harvest sites, and air quality for other people working in Ontario's managed forests.

"To minimize environmental impacts of biomass harvesting it will be essential to determine an appropriate amount of residuals, coarse woody debris, and slash to leave behind."

For more information, contact Bell at (705)946-7401, wayne.bell@mnr.gov.on.ca.

Coming up in the next issue of Insights...

- NEBIE project reveals the effects of intensive forest management
- The latest news about OFRI's soils and hydrology research
- Update on propagating Canada yew to produce paclitaxel
- Research studies yield new information about natural fire regimes in Ontario
- And much more!

50808
(1.7k P.R., 06 05 15)
ISSN 1204-0436

2006, Queen's Printer for Ontario
Printed in Ontario, Canada

This paper contains recycled materials

Insights
A publication of the Ontario Forest Research Institute

Have a suggestion?

Want more information on a research project?

We want to hear from you!

CONTACT:
Abigail M. Obonchain,
Insights Editor

Lisa J. Buse,
Technology Transfer Coordinator
(or the specific OFRI researcher)

Ontario Forest Research Institute
Forest Research and Development Section
Applied Research and Development Branch
Ontario Ministry of Natural Resources
1235 Queen Street E., Sault Ste. Marie, ON
P6A 2E5 CANADA

information.ofri@mnr.gov.on.ca
http://ofri.mnr.gov.on.ca

(705)946-2981
Fax: (705)946-2030

Publication request line is ext. 271